

Engineering Management

Field Project

**Field Labeling to Ensure the Electrical Safety of
Production Equipment**

By

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EXECUTIVE SUMMARY

The Occupational Safety and Health Administration (OSHA) requires that all equipment that uses electrical power be certified as electrically safe by a Nationally Recognized Testing Lab (NRTL) or Authority Having Jurisdiction (AHJ) prior to being placed in service.

While it is very appropriate to ensure that workers and consumers are protected from electrical hazards in unsafe equipment the OSHA required procedures to obtain this end result can add undue complexity, cost and time to the manufacturing and delivery of new equipment.

This paper focuses on the size and type of equipment typically found in a manufacturing facility and what the best option(s) an equipment manufacturer would have in complying with regulations while controlling costs and maximizing their ability to rapidly deliver equipment that matches the needs of potential customers.

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LIST OF ABBREVIATIONS AND ACRONYMS

NRTL. Nationally Recognized Testing Lab

FE. Field Evaluation

FEB. Field Evaluation Body

AHJ. Authority Having Jurisdiction

OSHA. Occupational Safety and Health Administration

NFPA. National Fire Protection Association

ACES. American Council for Electrical Safety

LIST OF DEFINATIONS FROM NFPA STANDARDS

Approved. Acceptable to the Authority having Jurisdiction

Authority Having Jurisdiction. An organization, office, or individual responsible for enforcing the s of a code or standard, or for approving equipment, materials, an installation, or a procedure.

Field Evaluation. The process used to determine conformance with requirements for one-of-a-kind, limited production, used, or modified products that are not listed or field evaluated under a certification program.

Field Evaluation Body. An organization, or part of an organization, that performs field evaluations of electrical or other equipment.

Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material. Or service meets appropriate designated standards or has been tested and found suitable for a specific purpose.

Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacture indicates compliance with appropriate standards or performance in a specified manner.

Nationally Recognized Testing Laboratory. A laboratory that performs testing per nationally recognized standards and certifies products as stipulated in the *Code of Federal Regulations* and is recognized by the United States Occupational Safety and Health Administration (Fed OSHA).

Independent 3rd Party. Both the company making equipment and the company that has purchased or has already installed in their plant have a vested interest in seeing that this equipment is in production use. To preclude a conflict of interest, or the appearance of a conflict of interest an independent, technically competent individual or organization is utilized to ensure that the equipment being evaluated is safe and complies with the applicable standards.

CHAPTER 1 – INTRODUCTION

By understanding and complying with the regulations requiring 3rd party involvement in proving or validating that the equipment and products a company makes are electrically safe it is possible that not only can this cost be significantly reduced but the company will be able to offer products that are validated as being safe. Since most large, costly production equipment is unique with limited numbers being made each year it is both cost and manufacturing delivery time prohibitive to complete either the NRTL listing or labeling processes. In following the alternate Field Evaluation process to obtain a field label instead of the NRTL listing or labeling processes a company can minimize the ill-effects of regulatory compliance while ensuring that safe machines are being delivered.

This is a much more effective than coordinating a NRTL labeling inspection only after the equipment has been designed and manufactured or to depend on the local AHJ to validate that the equipment is safe prior to being placed into service. Also, at this stage of the delivery process customer awareness of a less than mature manufacturing process is possible due to additional costs, lengthened timeline and equipment that may not meet the applicable requirements for electrical safety.

By being proactive and understanding the regulations this process becomes an open book test for the company making their equipment. Their products are designed and manufactured for both functionality and safety with the designs and processes being updated as required to meet customer need and staying within regulatory requirements. The company will be immediately aware of any design flaws that may exist that cause non-compliance issues and this information can be immediately be put back into the designs so the next, like machines manufactured do not have the same shortcomings.

For equipment that is destined for use in the United States the National Fire Protection Association (NFPA) has recently released two publications that address this subject, the 2012 edition of NFPA 790: Standard for Competency of Third-Party Field Evaluation Bodies (FEB) and NFPA 791: Recommended Practice and Procedures for Unlabeled Electrical Equipment Evaluation. The intent of these standards is to provide a clear and concise means for the AHJ to approve a FEB and then a solid list of criteria for the FEB to follow as they field evaluate and then apply the appropriate field label to equipment as it passes evaluation.

There are a limited number of NRTL's that have been approved by OSHA to perform listing and labeling of electrical equipment. While they each have a

number of field offices to geographically match historical customer demand it is quite probable that they will need to travel to the manufacturing plant assembling and wiring the equipment since, by size it is not feasible to ship to the NRTL lab for testing. The resulting limitations placed on the NRTL for testing resources result in performance of tests and data gathering very similar to that available to a FEB. Provided a local FEB can demonstrate the required level of competency it is likely they can drive a higher level of both quality and service while lowering costs through increased competition.

CHAPTER 2 □ LITERATURE REVIEW

A company with a history of delivering electrically safe equipment combined with validation that future equipment will also be safe is better positioned to satisfy customer needs than a competitor who does not deliver safe products. At a minimum, by delivering safe products at a reasonable price a company will not be eliminated as a potential equipment supplier by being viewed in a negative light as a result of a poor safety evaluation.

OSHA posts information on their website detailing the number of times a standard was cited during inspections and the total yearly amount of resulting fines. During the period October 2010 through September 2011 OSHA issued 203 citations resulting in \$231,453 in fines for “Wiring methods, components, and equipment for general use” on “Industrial and Commercial Machinery and Computer Equipment.” Of the nine electric shock fatalities OSHA investigated in 2010 one was related to industrial equipment that did not protect the worker from receiving an electrical shock.

From the Legal Dictionary under Product Liability, “A manufacturer can be held liable for negligence if lack of reasonable care in the production, design, or assembly of the manufacturer's product caused harm.” Through the use of a third party to validate the safety of their machines a manufacturing company can

transfer the at least some, if not all the risk of lawsuits and associated expenses to the third party. Figures 1, 2 and 3 shown below are from the Electrical Safety Council International (EFSI) website. Overall, although Electrical Fatalities continue to trend downward there are still a large number of deaths that should avoidable. The number of fatal accidents caused by electric current on machines, tools and light fixtures is one of the three largest groups and is one of the top two categories of non-fatal electrical accidents.

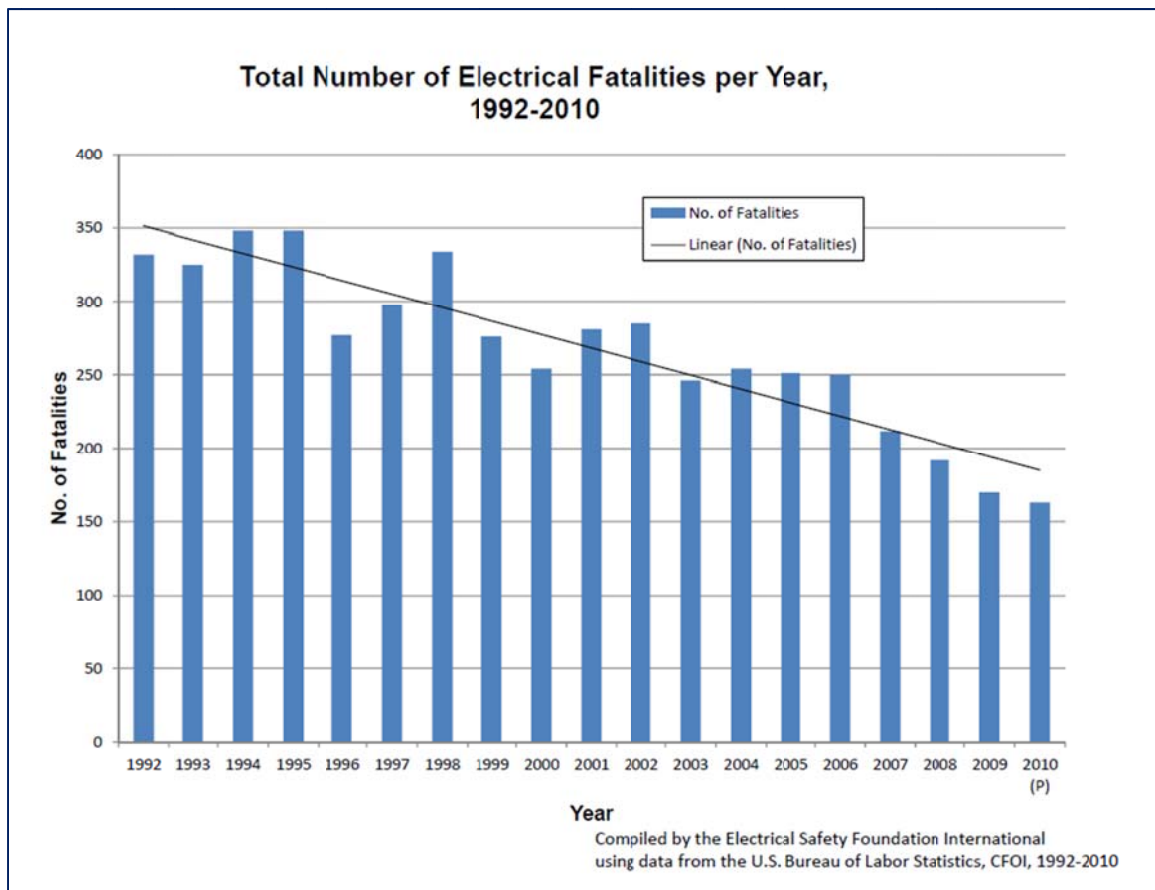


Figure 1: Electrical Fatalities per Year

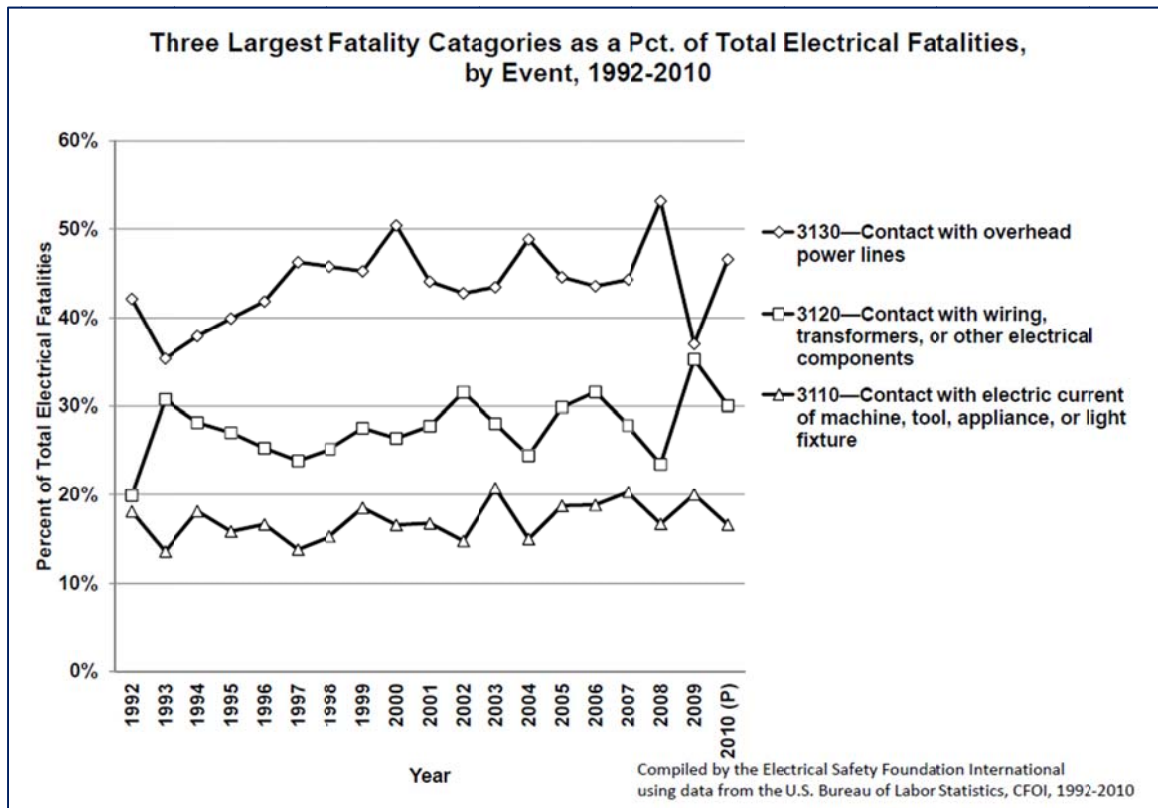


Figure 2: Largest 3 Electrical Fatality Categories

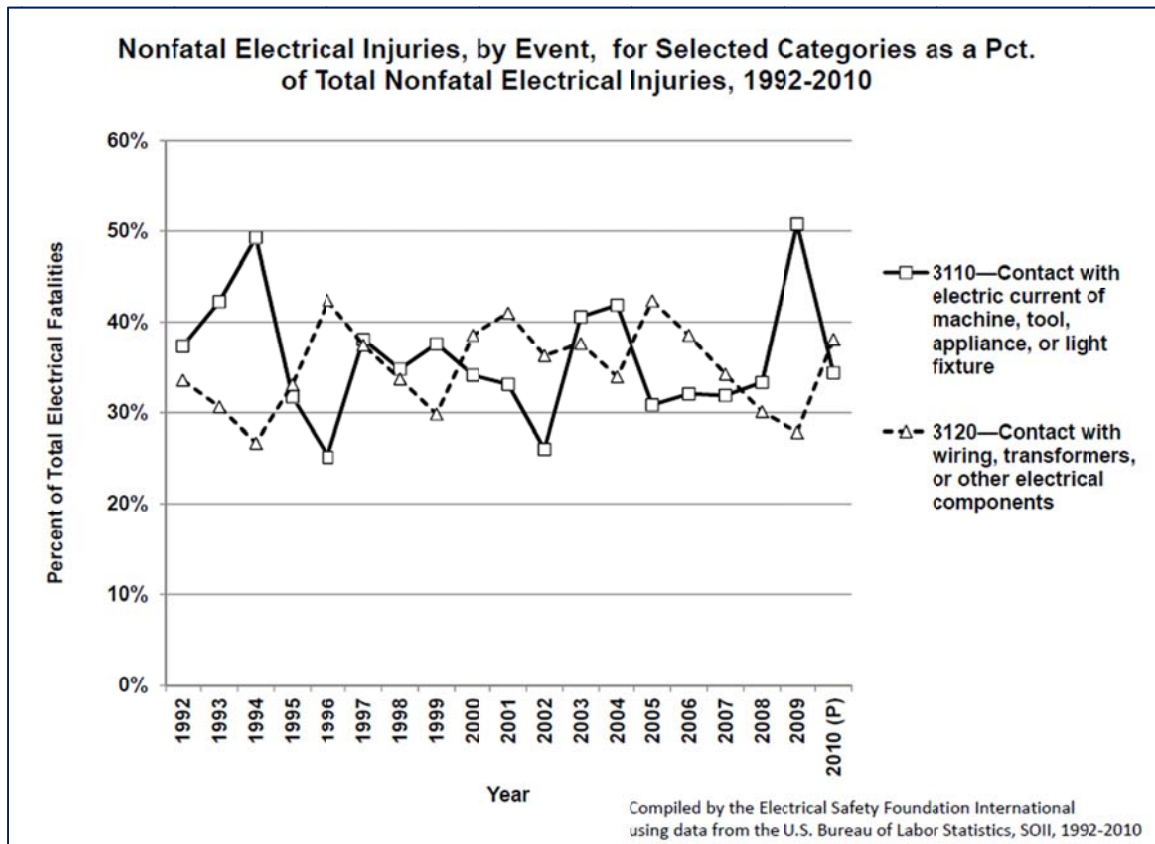


Figure 3: Nonfatal Electrical Injuries by Event Type

The Occupational Safety and Health Administration (OSHA) only accepts electrical equipment that has been approved (listed or labeled) by an NRTL as per Subpart S of Part 1910 Title 29, Code of Federal Regulations - 29 CFR Part 1910). Unfortunately, there are only 16 NRTL's recognized by OSHA of which not all review or approve the safety of electrical equipment. From the Frequently Asked Questions (FAQs) pages on the OSHA website.

“How does OSHA enforce the requirements for NRTL approval?”

OSHA primarily enforces the requirements for NRTL approval by: 1) recognizing NRTLs to assure itself that qualified organizations test and certify the safety of products used in the workplace, 2) auditing each NRTL annually to verify that it sustains the quality of its operation and continues to meet requirements for recognition, and 3) performing workplace inspections during which OSHA compliance officers (CSHOs) review specific products to check whether they contain the certification mark of an NRTL. OSHA may cite an employer and impose penalties if the officer finds improperly certified products for which OSHA requires certification.”

“Does OSHA have alternatives to NRTL "approval" of products?

OSHA Safety Standards for electrical equipment (subpart S of 29 CFR Part 1910) define the word "approved" as acceptable to the Assistant Secretary of Labor for Occupational Safety and Health. In addition, equipment is acceptable under this subpart if it is: 1) certified by an NRTL; 2) of a kind that no NRTL will certify and it is inspected or tested by another Federal agency, or by a state, municipal, or other local authority responsible for enforcing and assuring compliance with occupational safety provisions of the National Electrical Code; or 3) custom-made equipment, i.e., equipment designed, fabricated for, and intended for use by a particular customer, and determined to be safe by the manufacturer for its intended use.

OSHA considers the two alternatives to be minor exceptions to the requirements for NRTL approval of specific types of equipment. An NRTL can and must certify the vast majority of products requiring approval."

NFPA® 70 NEC (National Electric Code) 2008 Edition article 90.7 states that if an specific families or items of equipment are examined during production for safety by a “qualified electrical testing laboratory” (NRTL) and the resulting items are listed then the interior wiring of the equipment does not need to be inspected during installation except to ensure damage has not occurred during shipment of installation. This method is only cost effective if a large number of like items are produced and the costs can be amortized over what could be several years and literally thousands of items.

NFPA® 70B establishes a Recommended Practice for Electrical Equipment Maintenance. While this is intended more for the building infrastructure the equipment owner, being responsible for the ongoing safety of electrical equipment should include the elements of electrical preventative maintenance such as checking for grounding integrity, loose or frayed wires and damaged components. This is in addition to the maintenance procedures that are necessary to keep the equipment running and avoid costly or lengthy repairs.

NFPA[®] 79 sets forth the Electrical Standards for all Industrial Machinery that operates from 600V or less not including equipment that is designed for use in hazardous locations. This publication provides compressive information on how to apply electrical components, wiring and control systems to both ensure safety of personnel and aid in the delivery of reliable, maintainable machines. In Appendix A.3.2.1 this standard states “In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling process practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with the appropriate standards for the current production of listed items.”

NFPA[®] 790 is a standard designed for Determining Competency of Third Party Evaluation Bodies. “This standard provides the requirements of the competency of an FEB by an authority having jurisdiction or other recognition body.” In addition, it outlines the standard parts of an operating system that NFPA has determined are necessary to be a success in providing evaluation

services. An appendix provides a sample format for an organization desiring recognition as a FEB to use in applying to the appropriate AHJ for credentials.

NFPA[®] 791 Recommended Practices and Procedures for Unlabeled Electrical Equipment Evaluation 2012 Edition. This standard provides a means to determine the safety of unlabeled equipment, to ensure compliance with recognized electrical safety standards and meet the expectations from that an AHJ may have for electrical equipment. Provided the equipment passes the evaluation the FEB applies a field evaluation label with a compliance report. This process can be used for new equipment, used equipment being purchased and equipment already installed and in use. It does not provide a means for a Company to have their equipment Listed or Labeled. In addition to the inspection procedures outlined in 791 the use of NFPA 79 as a reference to follow would be well advised.

Predating NFPA 790 and 791, the Council for Electrical Safety (ACES) published a reference standard for field evaluations and field labeling of Electrical Equipment. During my research I found that this standard is in use by at least one NRTL as they complete field evaluations. Since they have already been examined by OSHA (AHJ on a national level) and granted NRTL status obtaining FEB status is not required.

Andrews, McClung and White (Ensuring that Electrical Equipment is Safe for its Intended Use) in their article for IEEE make a case that all electrical equipment must pass a safety evaluation. If it is not possible to obtain listed or labeled equipment a safety evaluation must be done in accordance with OSHA regulations and recognized codes and standards. They also state that the AHJ has two functions, one is the initial purchase and installation and then the second being the safe operation and ongoing maintenance of the equipment. Their article, while twelve years old is as relevant today as when it was published. Unfortunately, this also is a reflection in how little improvement there has been in the processes followed to help ensure that equipment is electrically safe.

On January 18, 2011 the President signed an Executive Order directing improvements in regulation and regulatory review. He stated, “Our regulatory system must protect public health, welfare, safety, and our environment while promoting economic growth, innovation, competitiveness, and job creation. It must be based on the best available science. It must allow for public participation and an open exchange of ideas. It must promote predictability and reduce uncertainty. It must identify and use the best, most innovative and least burdensome tools for achieving regulatory ends. It must take into account benefits and costs, both quantitative and qualitative. It must ensure that regulations are accessible, consistent, written in plain language, and easy to

understand. It must measure, and seek to improve, the actual results of regulatory requirements.”

Rather than depend on regulations and third party evaluators acting as gate keepers to prevent unsafe equipment from being in service it would be much more effective to eliminate the safety issues during the equipment design stage. As part of mistake-proofing a process or procedure The American Society for Quality (ASQ) suggests that to eliminate errors use “Facilitation – making the correct action far easier than the error.”

Underwriter Laboratories (UL) in a recently completed study (Navigating the Product Mindset High-Tech Index Report) asked both consumers and manufactures who is most responsible for product safety. As shown below in Figure 4, the consensus feeling is that this is the responsibility of the manufacturer and not Government or an NRTL. Since this sense of ownership already exists if a validation check early in the product design stages for code and regulation compliance is performed the safety evaluations that completed will find little to correct. Also, much like equipment should be maintained over time designs should be validated for ongoing compliance even if this means revisiting the patent process.



Figure 4: Product Safety Responsibilities

TUV Rheiland, an NRTL has recognized that they can be better positioned for Field Labeling of Industrial Equipment by expanding increasing their geographical base through the use of Contractors that they train to properly conduct field evaluations. This information on their Partnership Program is posted on their website. Not only are they keeping their overhead low they are positioned to take advantage of new business from field evaluation opportunities without giving up their current, NRTL listing and labeling business.

On their website ASQ suggests using a Decision or Pugh Matrix or when faced with having to choose solutions or options based on how well they solve a number of desired criteria a decision matrix can be employed to help choose the best solution, or a hybrid solution. The criteria is weighted to reflect

importance and the solutions are scored to reflect how well each solves or fits with each criteria. By multiplying each weighted criteria against the solution score and summing the result a quantitative result is obtained for each option. The option with the highest score, or a hybrid solution that maximizes scoring should be the solution used.

Chapter 3 □ Procedure and Methodology

A thorough review of the applicable regulations and standards looking for both inconsistencies and a reason for companies to justify the added expense associated with certifying and then labeling a piece of equipment as electrically safe if it not already listed or labeled was completed. This lead to the conclusion that all electrical equipment has to be designed, manufactured, installed, used and maintained in such a manner so that it is electrically safe throughout its life. As part of this process, when equipment is purchased and installed the listing and labeling process helps to ensure that the equipment, as delivered is safe. If equipment that is not listed or labeled is going to be put into use, or is already in use then the AHJ has the responsibility for ensuring that the equipment is safe.

There is no shortage of regulatory guidance and standards for production equipment manufacturers and production companies to follow as they make for sale or buy and put into service equipment that requires electrical energy in order to operate. Add to this the possibility of equipment that is not listed or labeled being installed and the AHJ only inspects the installation and not the equipment itself for code compliance and safety.

OSHA was contacted to determine if field evaluations by a body other than an NRTL is acceptable. They are unwilling to accept the use of an FEB to determine the electrical safety of equipment. When asked about the number of

NRTLs and the volume of work let alone the cost of an NRTL to label production equipment there was a marked lack of empathy.

Neither Missouri nor Kansas has a State Level OSHA program. Their offices are engaged with education and courtesy inspections with a local Federal OSHA office retaining responsibility for compliance audits and inspections. In talking with personnel in both offices it was obvious that all were focused on doing the best that they could to provide services to ensure the best possible working conditions in their state. Neither office could articulate who would approve a non-NRTL FEB if a local AHJ for a city or municipality or OSHA on a federal level would not.

A hierarchy of which process should be selected to ensure or validate the electrical safety of equipment is summarized below.

- Listed by a NRTL when the number of items produced per year is in the thousands or greater.
- Labeled by an NRTL when the number of items produced per year is in the hundreds.
- Field Labeled by an NRTL or a FEB approved by the appropriate AHJ when the number of items produced per years is in the single digits up to 100, is

unique and made for a specific customer, or for validating the safety and condition of used and existing equipment.

- AHJ inspections when all other options have failed to be utilized.

CHAPTER 4 □ RESULTS

Even if equipment has been determined to be safe through the listing, labeling or field evaluation labeling processes the company that will own and use the equipment still has responsibility to see that this equipment was installed properly, is used properly and remains safe through the appropriate maintenance programs and procedures.

If equipment that meets production needs is available as being either listed or labeled this is the preferred route to take. For unique equipment, or purchasing from a vendor that has not gone through the NRTL listing or labeling processes a Field Evaluations by an NRTL should be the path taken. Depending the AHJ or local electrical inspector to validate electrical safety is a less than desirable option since obtaining consistent results may not always be possible. Also, dependence on the quality data provided by a manufacture leaves a lot top be desired since this places total dependence on the maturity of their design and manufacturing processes.

NRTL 790 and 791 are still relatively new and are dependent on the AHJ approving a FEB as competent to perform field evaluations and field labeling. Given time and exposure, this process should gain in acceptance and then use. In the interim, use of a NRTL (approved by OSHA, the ultimate AHJ) to perform

field evaluations should be used. As equipment is modified to meet production requirements or changes to design are required to effect repairs, or used equipment is obtained a field evaluation should be performed.

This should be an open book test, the standards, regulations and codes are readily available for access. The end goal should be to prevent electrical injuries and deaths. By doing so, costs will be reduced, productivity should increase and likelihood of sustainability for a company's manufacturing processes should be enhanced.

CHAPTER 5 □ SUGGESTIONS FOR ADDITIONAL WORK

Develop acceptance by OSHA of a harmonized certification process or procedure to be used during the design and manufacture of US equipment being sold for use in the US and abroad. This would allow US companies to make safe equipment and better compete on a world-wide scale.

Find the appropriate lever or lobbying group to cause change to the Subpart S of Part 1910 Title 29, Code of Federal Regulations that will allow OSHA to accept the validity of a FEB that is not an NRTL. This should, in turn encourage both State level OSHA and local AHJ approval of this process.

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